Pre- and postweaning performance of pigs injected with dexamethasone at birth

A. M. Gaines, J. A. Carroll, G. L. Allee and G. F. Yi

J Anim Sci 2002. 80:2255-2262.

Pre- and postweaning performance of pigs injected with dexamethasone at birth[1,2]

A. M. Gaines*, J. A. Carroll†[3], G. L. Allee*, and G. F. Yi*

*University of Missouri-Columbia and †Animal Physiology Research Unit, ARS-USDA, Columbia, MO 65211

ABSTRACT: A trial was conducted to determine pre- and postweaning performance of pigs injected with dexamethasone either 1 or 24 h after birth. In Exp. 1, 225 pigs (Triumph4 × PIC Camborough 22) were assigned according to birth weight and sex to three treatments. Treatments included either saline (Control), Dex1 (2 mg/kg BW i.m. injection of dexamethasone within 1 h of birth), or Dex24 (2 mg/kg BW i.m. injection of dexamethasone within 24 h after birth). Birth weights (1.56 ± 0.06 kg) did not differ among treatments ($P > 0.10$) or between sexes ($P > 0.10$). There was a treatment × sex interaction on BW at weaning (15 d; $P < 0.05$) with Dex1 and Dex24 males 10% heavier than Control males (4.77 and 4.78 vs. 4.34 kg, respectively), and no significant differences in BW among the females ($P > 0.05$). In Exp. 2, 180 pigs from Exp. 1 were transported to a segregated early weaning nursery facility where each sex was assigned to 10 pens per treatment (60 pens total). Pigs were fed fortified corn-soybean meal diets in a three-phase feeding program. At the end of Exp. 2 (49-d period), there was a treatment × sex interaction ($P < 0.01$) for BW with Dex1 and Dex24 barrows being on average 8% heavier than the Control barrows (30.1 and 29.8 vs. 27.7 kg, respectively), and no significant difference in BW ($P > 0.10$) among the gilts. No treatment differences in feed efficiency (gain:feed) were observed during the nursery period ($P > 0.10$). In Exp. 3, pigs from the nursery were moved to a finishing facility where each sex was assigned to 4 pens per treatment (24 pens total). All pigs were fed fortified corn-soybean meal diets in a four-phase feeding program with sexes fed separately. Real-time ultrasound was used to measure 10th rib backfat depth and longissimus muscle area. At the end of Exp. 3 (83-d period), there was a treatment × sex interaction ($P < 0.05$) for final BW with Dex1 and Dex24 barrows being on average 5.45 kg heavier than Control barrows (119.6 and 120.7 vs. 114.4 kg, respectively), and no difference ($P > 0.05$) in BW among the gilts. No treatment differences ($P > 0.10$) were observed for backfat depth, longissimus muscle area or gain:feed. These studies demonstrate that dexamethasone (2 mg/kg BW) given within 24 h of birth significantly improves both pre- and postweaning performance of barrows with no beneficial effects on gilts.

Key Words: Dexamethasone, Parturition, Pigs

 J. Anim. Sci. 2002. 80:2255–2262

Introduction

After parturition, the piglet undergoes transient changes in growth and development. The causative factors that elicit the changes allowing the newly born pig to survive outside the uterine environment are not clear. In the pig, adrenal sensitivity and plasma cortisol concentrations increase in late gestation, peak at birth, and decrease significantly the first week postnatally (Dvorak, 1972; Silver & Fowden, 1989). It has been suggested that the glucocorticoid surge at birth is the endocrine signal necessary for maturational changes in the postnatal pig (Silver, 1990). Carroll et al. (2000) reported that circumventing the glucocorticoid surge associated with the natural birth process, via caesarian section, reduces piglet growth and alters the somatotrophic axis. This would suggest that the cortisol surge at the time of parturition is an important regulator of postnatal growth and development. Recently, Carroll (2001) found that dexamethasone (a synthetic glucocorticoid) given to baby pigs within 1 h of birth increases weaning weight 10.1% compared with pigs not injected with dexamethasone. This increase in weaning weight suggests opportunities immediately after birth to alter

[1]Mention of a trade name or proprietary product does not constitute a guarantee or warranty of the product by the USDA and does not imply its approval to the exclusion of other products that may also be suitable.

[2]Appreciation is expressed to Chinn Hog Farms for allowing us to use their facilities to conduct part of this research and to Meghan Billups for carcass data collection.

[3]Correspondence: Animal Sciences Research Center (phone: (573) 882-6261; fax: (573) 884-4798; E-mail: CarrollJA@Missouri.edu).

Received January 30, 2002.
Accepted April 10, 2002.

the endocrine system and subsequent growth. To date, there have been no attempts to determine the long-term effects of dexamethasone injection subsequent to weaning or whether it is effective when given 1 h past parturition. Therefore, the objective of this study was to determine the effects of dexamethasone administered via injection within 24 h of parturition on pre- and postweaning performances of both male and female pigs.

Materials and Methods

Experiment 1

This experiment was conducted at an 1,800 head commercial sow unit. For this experiment, 225 pigs (Triumph 4 × PIC Camborough 22) were used from primiparous and multiparous sows. To avoid the confounding effects of parity and (or) litter, pigs were randomly assigned within the litter by birth weight and sex to three treatments in a 3 × 2 factorial arrangement. Treatments included either an intramuscular injection of sterile saline (Control), dexamethasone solution (Pheonix Pharmaceuticals, Inc., St. Joseph, MO) at 2 mg/kg body weight (BW) within 1 h of birth (Dex1), or dexamethasone solution at 2 mg/kg BW within 24 h of birth (Dex24). Dosage was determined by weighing the pig immediately after birth. After receiving either the saline or dexamethasone injection, pigs were processed and remained within their respective litter until termination of the experiment. All sows received an intramuscular injection of 5 mg dinoprost tromethamine (Lutalyse; Pharmacia Upjohn Company, Kalamazoo, MI) at 113 d of pregnancy to synchronize parturition. For all treatments, pigs were individually weighed at weaning (d 15) before being transported to an off-site segregated early-weaning nursery facility.

Experiment 2

Due to limited finishing space, a total of 180 pigs (age = 15 d) from Exp. 1 were moved to an off-site segregated early-weaning nursery facility. Sexes were separately assigned to pens by weight and previous birth treatment with 10 replications per treatment (60 pens total). Pigs of the same treatment were housed (3 pigs/pen) in a mechanically ventilated nursery facility equipped with slotted rubber floors, self-feeders, and automatic waterers for the 49-d experiment. The temperature of the nursery room was initially 32.0°C and was decreased weekly to a target temperature of 18.0°C. All pigs were fed common corn-soybean-meal-fortified diets in a three-phase starter-feeding program. Diets met and(or) exceeded NRC (1998) nutrient specifications. During the experiments, individual animals were observed for overall health each day. Body weight and feed intake were measured weekly.

Experiment 3

All pigs from Exp. 2 were moved to an off-site finisher facility. Sexes were separately assigned to pens by weight and previous birth treatment with 4 replications per treatment (24 pens total). Pigs of the same treatment were housed (7 to 8 pigs/pen) in a naturally ventilated modified open-front finisher facility equipped with partially slatted concrete floors, self-feeders, and automatic waterers for the 83-d experiment. All pigs were fed common corn-soybean-meal fortified diets in a four-phase feeding program with sexes fed separately starting at 45 kg. Diets met and(or) exceeded NRC (1998) nutrient specifications. During the experiment, individual animals were observed each day for overall health. Body weight and feed intake were measured every 21 d for all pigs. In addition, real-time ultrasound (Aloka Model SSD-500 V; Corometrics, Wallington, CT) was used to measure 10th rib backfat depth and longissimus muscle area at each dietary phase change. Serial ultrasound measurements were recorded for three pigs in each pen. At 83 d (approximately 115 kg BW) pigs were transported to a commercial abattoir to evaluate carcass traits and meat quality attributes. Immediately after harvest, measurements of carcass weight, Fat-O-Meater (SFK Technology; Cedar Rapids, IA) measured 10th rib fat depth, loin depth, and calculated carcass percentage lean were recorded on all carcasses (169 total). Carcasses were then placed in a cooler (2.8°C) and further chilled via a conventional spray chill system that cycled every 30 min. At 24 h post-mortem, the longissimus muscle at the 10th rib and the ham semimembranosis were measured for ultimate pH (Mettler Toledo, Hightstown, NJ) on 2 pigs/pen (48 carcasses total). Belly thickness at the last rib was also measured on all 48 carcasses. At fabrication, the hams, bellies (left and right), and bone in loins were harvested and weighed. Boneless loins were also harvested for objective meat-quality measurements that included ColorTec-PCM Colorimeter (Pittsford, NY) L*, a*, and b* values. The ColorTec-PCM Colorimeter was calibrated with both a black and white tile. The University of Missouri-Columbia Animal Care and Use Committee reviewed and approved all animal protocols in the present study.

Statistical Analysis

In Exp. 1, birth and wean weights were subjected to analysis of variance using the GLM procedure of SAS (SAS Inst. Inc., Cary, NC), and LS mean comparisons were made using Fisher's Protected Least Significant Difference. The statistical model included effects of birth treatment, sex, and interactions with pig as the experimental unit. In Exp. 2, growth performance data were subjected to analysis of variance using the GLM procedure of SAS, and mean comparisons were made using Fisher's Protected Least Significant Difference. The statistical model included effects of sex, birth treat-

Table 1. Effect of dexamethasone injection on body weight from birth until 15 d of age (Exp. 1)[a]

	Barrows[b]			Gilts[b]				
Variable	Control	Dex1	Dex24	Control	Dex1	Dex24	Effect[c]	SEM
Number of pigs	39	42	40	36	33	35	—	—
Number of deaths	2	3	4	1	0	2	—	—
Birth wt (kg)	1.52	1.59	1.61	1.59	1.53	1.53	NS	0.06
15 d BW (kg)	4.34[e]	4.77[d]	4.78[d]	4.77[d]	4.39[de]	4.54[de]	T × S*	0.15

[a]Data represent LS means for each treatment.
[b]Barrows and gilts were injected with dexamethasone (2 mg/kg body weight) within 1 h of birth (Dex1); 24 h of birth (Dex24); or injected with sterile saline (Control).
[c]Effect: T × S* = Treatment × Sex interaction ($P < 0.05$); NS = not significant ($P > 0.10$).
[de]Means in a row without a common superscript letter differ ($P < 0.05$).

ment, replication within sex, and included the interaction of birth treatment × sex with pen as the experimental unit. In Exp. 3, growth performance data were subjected to analysis of variance using the GLM procedure of SAS and mean comparisons were made using Fisher's Protected Least Significant Difference. The statistical model included effects of sex, birth treatment, replication within sex, and the interaction of birth treatment × sex with pen as the experimental unit. For ultrasound, carcass, and meat-quality measurements, data were subjected to analysis of variance using the GLM procedure of SAS, and LS mean comparisons were made using Fisher's Protected Least Significant Difference. The statistical model included effects of sex, birth treatment, and interactions with pig as the experimental unit.

Results

Experiment 1

Birth to weaning data are presented in Table 1. Birth weights (1.56 ± 0.06 kg) did not differ among treatments ($P > 0.10$) or between sexes ($P > 0.10$). A treatment × sex interaction ($P < 0.05$) was detected for BW at weaning with both Dex1- and Dex24-treated males 10% heavier than Control males, and no significant differences in BW at weaning among treatment groups in the females ($P > 0.05$).

Experiment 2

Growth performance data for Exp. 2 are presented in Table 2. At the end of Exp. 2 (49-d period), there was a treatment × sex interaction for ADG ($P < 0.10$) and BW ($P < 0.01$) with Dex1 and Dex24 barrows having a higher ADG, and on average, an 8% heavier BW than Control barrows. There were no treatment differences for ADG or BW between Dex1 barrows and Dex24 barrows ($P > 0.10$). There were also no significant differences in ADG or BW observed among treatment groups in the gilts ($P > 0.10$). In addition to dexamethasone-treated barrows being heavier at the end of the nursery, they also had higher daily feed intakes (treatment × sex interaction; $P < 0.05$) for the overall nursery period. However, daily feed intakes did not differ among treatment groups in the gilts ($P > 0.10$).

Experiment 3

Growth performance data for Exp. 3 are presented in Table 3. At the end of Exp. 3 (83-d period) there was a treatment × sex interaction for ADG ($P < 0.10$) and final BW ($P < 0.05$) with Dex1 and Dex24 barrows having a higher ADG, and on average, a 5.45-kg heavier BW than Control barrows. In addition to dexamethasone-treated barrows being heavier at the end of the finisher phase than Control barrows, they also had higher daily feed intakes (treatment × sex interaction; $P < 0.10$) than Control barrows for the overall finishing phase. There were no significant treatment differences in ADG ($P > 0.10$) or BW ($P > 0.10$) between Dex1 and Dex24 barrows. Also, there were no treatment differences in ADG ($P > 0.10$) or BW ($P > 0.05$) observed among treatment groups in the gilts. A sex effect was observed for gain:feed ($P < 0.05$) such that barrows gained faster and consumed more feed, but were less efficient than gilts. Ultrasound data for Exp. 3 are presented in Table 4. Real-time ultrasound measurements indicated no treatment differences for final backfat depth ($P > 0.10$) and longissimus area ($P > 0.10$); however, there was an overall sex effect ($P < 0.01$) for final backfat depth with gilts being leaner than barrows. Carcass data for Exp. 3 are presented in Table 5. Carcass data collected from a commercial processing facility indicated a treatment × sex interaction ($P < 0.01$) for hot carcass weight with Dex1 and Dex24 barrows having on average 4.2 kg heavier carcass weights than Control barrows. There were no significant treatment differences in hot carcass weight between Dex1 and Dex24 barrows ($P > 0.10$). Also, there were no treatment differences observed for hot carcass weight ($P > 0.05$) among treatment groups in the gilts. Fat-O-Meater data were consistent with ultrasound data indicating no differences between treatment for backfat depth ($P > 0.10$) and loin depth ($P > 0.10$); however, a sex effect ($P < 0.001$) was detected for backfat depth with gilts being leaner than barrows. In addition, calculated carcass percentage lean indi-

Table 2. Effect of dexamethasone injection on growth performance in nursery pigs (Exp. 2)[a]

	Barrows[b]			Gilts[b]				
Variable	Control	Dex1	Dex24	Control	Dex1	Dex24	Effect[c]	SEM
Initial wt, kg	4.7[ef]	5.1[d]	5.0[d]	5.0[d]	4.5[f]	4.7[e]	T × S***	0.04
Day 0 to 13 Phase 1								
13 d wt, kg	7.7[e]	8.2[d]	8.3[d]	8.2[d]	7.6[e]	7.7[e]	T × S**	0.06
ADG, kg	0.24	0.24	0.25	0.24	0.24	0.24	NS	0.005
ADFI, kg	0.29	0.31	0.31	0.32	0.31	0.30	NS	0.005
Gain:feed, kg/kg	0.80	0.77	0.81	0.77	0.76	0.78	NS	0.009
Day 13 to 34 Phase 2								
34 d wt, kg	18.2[e]	20.2[d]	20.0[d]	19.2[de]	18.8[e]	18.5[e]	T × S**	0.16
ADG, kg	0.50[e]	0.57[d]	0.56[d]	0.53[de]	0.53[e]	0.51[e]	T × S*	0.005
ADFI, kg	0.67	0.74	0.72	0.70	0.70	0.67	NS	0.01
Gain:feed, kg/kg	0.76	0.77	0.78	0.75	0.76	0.76	NS	0.005
Day 34 to 49 Phase 3								
49 d wt, kg	27.7[e]	30.1[d]	29.8[d]	28.4[e]	28.2[e]	27.5[e]	T × S**	0.18
ADG, kg	0.68	0.70	0.69	0.66	0.68	0.65	S*	0.005
ADFI, kg	1.03[e]	1.08[de]	1.14[d]	1.08[de]	1.07[de]	1.02[e]	T × S**	0.01
Gain:feed, kg/kg	0.66	0.66	0.61	0.62	0.63	0.64	NS	0.007
Cumulative period Day 0 to 49								
ADG, kg	0.48	0.52	0.51	0.49	0.49	0.48	T × S†	0.005
ADFI, kg	0.67[e]	0.72[d]	0.73[d]	0.71[de]	0.71[de]	0.67[e]	T × S*	0.01
Gain:feed, kg/kg	0.72	0.72	0.70	0.69	0.70	0.71	NS	0.004

[a]Data represent the means of 10 replicate pens with three pigs each.
[b]Barrows and gilts were injected with dexamethasone (2 mg/kg body weight) within 1 h of birth (Dex1); 24 h of birth (Dex24); or injected with sterile saline (Control).
[c]Effect: S* = Sex ($P < 0.05$); T × S*, T × S**, T × S***, T × S† = Treatment × sex interaction ($P < 0.05$, 0.01, 0.001, and 0.10, respectively); NS = not significant ($P > 0.10$).
[d,e,f]Means within a row without a common superscript letter differ ($P < 0.05$).

cated a sex effect ($P < 0.001$) with gilts having a higher percentage lean than barrows. Meat-quality data for Exp. 3 are presented in Table 5. Meat-quality data indicated no treatment effects for ham ultimate pH ($P > 0.10$), loin ultimate pH ($P > 0.10$), or ColorTec-PCM L* ($P > 0.10$), a* ($P > 0.10$), and b* values ($P > 0.10$). Also, no treatment differences were observed for loin weights ($P > 0.10$) and belly weights ($P > 0.10$).

Discussion

Although the somatotrophic axis is considered to be essential for postnatal growth, it is widely believed that its role in neonatal piglet growth is relatively limited (Louveau, et al., 2000). However, recent studies have indicated that the somatotrophic axis is functional in the neonatal pig and can be influenced by exogenous hormone therapies such as porcine GH (Matteri et al., 1997; Lewis et al., 1998; Wester et al., 1998) and dexamethasone treatment (Burrin et al., 1999; Carroll, 2001). Current findings using dexamethasone treatment in piglets point to the need for careful attention to dose, age, and sex in analyses of glucocorticoid effects on the somatotrophic axis.

A previous study by Weiler et al. (1997) reported that long-term dexamethasone (0.5 mg/kg body wt) administration to 7-d-old pigs for 15 d resulted in reduced piglet growth and increased protein catabolism. Burrin et al. (1999) also reported that chronic administration of dexamethasone (1 mg/kg body wt) to 2-d-old pigs for 7 d reduced piglet growth rate and intestinal growth via increased protein catabolism. However, observations by Carroll (2001) suggest that a single dose of dexamethasone treatment to piglets within 1 h of birth stimulates the somatotrophic axis in a manner that enhances postnatal growth. The discrepancies between the studies using dexamethasone suggest that the response of the somatotrophic axis to glucocorticoids may be dose- and age-dependent.

Carroll (2001) observed a 10.1% increase in BW at weaning (d 18) when pigs were administered dexamethasone (1 mg/kg body wt) within 1 h of birth, which was attributed to stimulation of the somatotrophic axis. In the present study, the single dose administration of dexamethasone (2 mg/kg body wt) within 1 or 24 h of birth may have also altered the somatotrophic axis, which led to a 10% increase in body weight at weaning; however, this effect was only observed in the males. Graham et al. (1981) demonstrated that initial weight at weaning has a curvilinear effect on ADG, with each increment in initial weaning weight resulting in a higher, but progressively less rapid, rate of gain. Thus, any improvement in piglet gain with dexamethasone treatment during the preweaning period should have an overall effect on subsequent growth performance and days to market.

Table 3. Effect of dexamethasone injection on growth performance in finishing pigs (Exp. 3)[a]

	Barrows[b]			Gilts[b]				
Variable	Control	Dex1	Dex24	Control	Dex1	Dex24	Effect[c]	SEM
Initial wt, kg	28.1[ef]	30.1[d]	30.0[d]	28.8[e]	28.5[e]	27.6[f]	T × S***	0.24
Day 0 to 21 Phase 1								
21 d wt, kg	45.9[e]	48.1[d]	48.4[d]	46.2[e]	46.4[e]	45.2[e]	T × S**	0.41
ADG, kg	0.85	0.86	0.88	0.83	0.85	0.83	NS	0.01
ADFI, kg	1.61	1.68	1.69	1.64	1.64	1.59	NS	0.03
Gain:feed, kg/kg	0.53[d]	0.51[de]	0.52[de]	0.51[e]	0.52[de]	0.53[d]	T × S*	0.006
Day 21 to 42 Phase 2								
42 d wt, kg	66.8[e]	69.6[d]	70.1[d]	67.1[e]	68.3[de]	66.6[e]	T × S*	0.26
ADG, kg	0.99	1.03	1.03	1.03	1.04	1.02	NS	0.03
ADFI, kg	2.36	2.44	2.50	2.28	2.25	2.21	S**	0.07
Gain:feed, kg/kg	0.43	0.44	0.42	0.45	0.46	0.47	S**	0.01
Day 42 to 63 Phase 3								
63 d wt, kg	91.6[ef]	96.8[d]	97.4[d]	92.5[ef]	93.0[e]	89.9[f]	T × S*	0.95
ADG, kg	1.18	1.23	1.30	1.17	1.18	1.11	S*	0.04
ADFI, kg	2.91[ef]	3.00[de]	3.17[d]	2.70[g]	2.79[fg]	2.61[g]	T × S*	0.06
Gain:feed, kg/kg	0.41	0.41	0.41	0.43	0.42	0.42	NS	0.01
Day 63 to 83 Phase 4								
83 d wt, kg	114.4[f]	119.6[de]	120.7[d]	115.3[f]	115.8[ef]	112.1[f]	T × S*	1.37
ADG, kg	1.04	1.11	1.15	1.13	1.12	1.09	NS	0.04
ADFI, kg	3.42	3.47	3.66	3.40	3.45	3.34	NS	0.10
Gain:feed, kg/kg	0.31	0.32	0.32	0.33	0.33	0.33	S*	0.008
Day 0 to 83 Cumulative								
ADG, kg	1.03[b]	1.08[a]	1.09[a]	1.03[b]	1.05[ab]	1.02[b]	T × S†	0.01
ADFI, kg	2.55	2.62	2.74	2.49	2.51	2.43	T × S†	0.05
Gain:feed, kg/kg	0.40	0.40	0.40	0.42	0.42	0.42	S*	0.002
Total days birth to market[h]	145.4[de]	141.0[fg]	140.4[g]	144.4[def]	144.0[efg]	147.6[d]	T × S*	1.17

[a]Data represent the means of four replicate pens with 7 or 8 pigs each.
[b]Barrows and gilts were injected with dexamethasone (2 mg/kg body weight) within 1 h of birth (Dex1); 24 h of birth (Dex24); or injected with sterile saline (Control).
[c]Effect: S* = Sex ($P < 0.05$); T × S*, T × S**, T × S***, T × S† = Treatment × Sex interaction ($P < 0.05$, 0.01, 0.001, and 0.10, respectively); NS = not significant ($P > 0.10$).
[defg]Means within a row without a common superscript letter differ ($P < 0.05$).
[h]Adjusted days from birth to a market weight of 113.4 kg.

Table 4. Effect of dexamethasone injection on serial ultrasound measurements in finishing pigs (Exp. 3)[a]

	Barrows[b]			Gilts[b]				
Variable	Control	Dex1	Dex24	Control	Dex1	Dex24	Effect[c]	SEM
Number of pigs	12	12	12	12	12	12		
Day 21 Phase 1								
10th rib backfat depth, cm	1.07	1.00	1.07	1.04	0.97	0.99	NS	0.05
10th rib longissimus muscle area, cm^2	18.06	18.39	17.16	17.68	17.94	17.68	NS	0.52
Day 42 Phase 2								
10th rib backfat depth, cm	1.57	1.27	1.47	1.32	1.27	1.42	NS	0.08
10th rib longissimus muscle area, cm^2	24.90	24.90	23.87	25.55	25.29	24.77	NS	0.71
Day 63 Phase 3								
10th rib backfat depth, cm	1.78	1.73	1.98	1.70	1.52	1.57	S*	0.10
10th rib longissimus muscle area, cm^2	32.00	32.39	31.10	32.71	32.65	32.00	NS	0.90
Day 83 Phase 4								
10th rib backfat depth, cm	2.21	2.08	2.24	1.85	1.80	1.81	S**	1.10
10th rib longissimus muscle area, cm^2	39.87	39.48	38.39	40.00	38.90	38.52	NS	0.97

[a]Values represent LS means for each treatment.
[b]Barrows and gilts were injected with dexamethasone (2 mg/kg body weight) within 1 h of birth (Dex1); 24 h of birth (Dex24); or injected with sterile saline (Control).
[c]Effect: S* and S** = Sex ($P < 0.05$ and 0.01, respectively); NS = not significant ($P > 0.10$).

Table 5. Effect of dexamethasone injection on carcass characteristics and meat quality attributes in finishing pigs (Exp. 3)[a]

	Barrows[b]			Gilts[b]				
Variable	Control	Dex1	Dex24	Control	Dex1	Dex24	Effect[c]	SEM
Carcass data								
Number of pigs	28	27	29	28	28	29		
Hot carcass wt/kg	85.1[ef]	88.4[de]	90.2[d]	85.2[ef]	86.3[ef]	82.9[f]	T × S**	1.27
Carcass yield (%)	74.3	73.6	74.6	74.4	74.7	74.1	NS	0.41
FOMBF, mm[g]	22.4	22.1	24.0	20.4	20.0	19.3	S***	0.81
FOMMD, mm[h]	48.9	51.0	49.8	51.3	50.0	50.6	NS	1.33
FOMLEAN, %[i]	51.1	51.5	50.2	52.6	52.7	53.3	S***	0.53
Meat quality data								
Number of pigs	8	8	8	8	8	8		
Belly thickness, mm	44.0	44.3	42.6	42.3	44.3	42.8	NS	2.11
Ham ultimate pH	5.85	5.87	5.80	5.82	5.81	5.78	NS	0.06
Loin ultimate pH	5.49	5.53	5.49	5.51	5.51	5.50	NS	0.03
ColorTec L*	47.6	47.8	46.9	48.6	46.6	48.8	NS	1.14
ColorTec a*	–1.83	–1.52	–1.72	–1.75	–2.13	–2.01	NS	0.33
ColorTec b*	7.66	8.00	8.18	7.40	7.63	7.64	NS	0.52
Total loin wt, kg	18.3	19.8	19.9	19.2	19.5	18.5	NS	1.24
Total belly wt, kg	13.6	13.6	15.4	14.2	13.9	13.7	NS	1.46
Total ham wt, kg	21.5	22.0	22.0	21.2	21.8	20.7	NS	1.21

[a]Data represent LS means for each treatment.
[b]Barrows and gilts were injected with dexamethasone (2 mg/kg body weight) within 1 h of birth (Dex1); 24 h of birth (Dex24); or injected with sterile saline (Control).
[c]Effect: S*** = Sex ($P < 0.001$); T × S** = Treatment × Sex interaction ($P < 0.01$); NS = not significant ($P > 0.10$).
[d,e,f]Means within a row without a common superscript letter differ ($P < 0.07$).
[g]FOMBF: Fat-O-Meater (SFK Technology, Cedar Rapids, IA) measured fat depth collected at a commercial abattoir.
[h]FOMMD: Fat-O-Meater measured loin depth collected at a commercial abattoir.
[i]FOMLEAN: Fat-O-Meater calculated percentage lean collected at a commercial abattoir.

A previous study by Mahan and Lepine (1991) reported that a 2.8 kg difference in weaning weight (4.7 vs. 7.5 kg) translated into a 15-d difference in days to 105.0 kg. In the present study, both dexamethasone treatments (1 or 24 h of birth) increased weaning weight approximately 0.44 kg, which on average translated into a 4-d difference in days to market (Table 3). Thus, any growth advantage achieved by dexamethasone treatment during the preweaning period was maintained through the nursery and grow-finish periods. This indicates that glucocorticoid treatment is beneficial for neonatal pigs and suggests that dexamethasone injection within 24 h of birth could be applied in production systems to increase weaning weights, and accelerate piglet growth performance.

In young piglets, dexamethasone, at doses similar to those used in premature infants, has been shown to induce protein catabolism and alter body composition (Weiler et al., 1997). In the present study, dexamethasone administered within 1 or 24 h of birth accelerated piglet growth and had no effect on carcass composition. If dexamethasone treatment did cause protein catabolism post-injection, this effect could have been offset by the dexamethasone-treated pigs consuming more colostrum or more milk than saline-injected controls during early lactation when milk production is not limiting.

Widdowson et al. (1976) first reported that colostrum elicits dramatic growth of the gastrointestinal tract, and especially of the small intestine. It has also been shown that the ad libitum consumption of colostrum by the piglet during the first 36 h postnatally induces an 80% increase in small intestinal weight (Schober et al., 1990; Le Dividich et al., 1997). The apparent cause of an increase in intestinal weight is due to both a transient retention of colostral macromolecules and enhanced protein synthesis (Burrin et al. 1992). In the present study, if dexamethasone treatment stimulated food intake and pigs were consuming more total milk, this could have resulted in increased protein synthesis. It has been reported that colostrums or milk feeding stimulates whole body protein synthesis (Burrin et al., 1992), which can be attributed to the presence of a number of growth factors in mammary secretions, including epidermal growth factor and insulin-like growth factor I. While we cannot conclude that dexamethasone treatment increased milk intake in the current study, we also cannot dismiss the relationship between preweaning growth and milk intake.

Both colostrum and milk are extremely well utilized by the piglet, with the apparent digestibility of energy and nitrogen both averaging 98.5% (Marion and Le Dividich, 1999). When the young piglet establishes suckling, growth is almost entirely dependent on colostrum and milk availability. This fact is supported by the work of Noblet and Etienne (1987) where preweaning growth was strongly related to sow milk output ($r^2 = 0.87$ to

0.90). Thus, in the current study it may be assumed that preweaning growth was driven by higher intakes of both colostral proteins and(or) total milk. This hypothesis is based upon studies in mice where glucocorticoids increased food intake reversing the effects of leptin without increasing hypothalamic neuropeptide Y mRNA (Solano and Jacobson, 1999). In any case, if dexamethasone treatment does indeed stimulate food intake in the neonatal pig, then the magnitude of the growth response will be most likely dependent on sow milk output.

As previously mentioned, the positive growth response in the male pig to dexamethasone treatment was not seen in the female pig, thus indicating a sexually dimorphic response to the dexamethasone treatment. Gallagher et al. (1999) also reported a sexually dimorphic response in neonatal piglets injected with GHRH. Growth hormone-releasing hormone enhanced growth in male piglets with no effects in female piglets. This suggests that the regulation of GH secretion in male and female pigs may be different even at an early stage of development and is consistent with differences reported for growth performance and carcass characteristics between barrows and gilts. Cromwell et al. (1993) reported differences in growth performance and carcass composition between barrows and gilts. Overall, barrows gained weight faster than gilts, but gilts required less feed per unit of gain and had less backfat, larger longissimus muscle areas, and a greater percentage of carcass muscle. In the present study, the gilts required less feed per unit gain, had less backfat, larger loin depths, and a higher percentage of carcass lean. The sexually dimorphic growth response to dexamethasone in the present study is contradictory to the results reported by Carroll (2001). Carroll reported no sex effects with dexamethasone treatment; however, in that particular study, dexamethasone was administered to piglets at 1 mg/kg body weight. The discrepancy in the present study and that of Carroll (2001) may indicate potential differences in glucocorticoid sensitivity in male and female pigs. Gallagher et al. (2002) reported differences in the development of a circadian pattern of salivary cortisol secretion between male and female neonatal pigs, with females establishing a circadian pattern by d 6, whereas males displayed a similar pattern from d 10 of birth. As with growth performance and carcass characteristics, glucocorticoid regulation and action are known to exhibit sexually dimorphic characteristics in several species (Vamvakopoulos, 1995; Tilbrook et al., 2000; Rhees et al., 2001).

In conclusion, results of the current study indicate that dexamethasone administered via injection within 24 h of birth significantly improves both pre- and postweaning performances of barrows with no beneficial effects on gilts. Given that there may be potential differences in glucocorticoid sensitivity in male and female pigs, additional studies are needed to determine the optimum concentration of dexamethasone to administer.

Implications

This study further demonstrates that the somatotrophic axis is functional in the neonatal pig and can be altered by dexamethasone to stimulate growth. This response appears to be sex-dependent with no beneficial effect in the gilt. However, pre- and postweaning performance can be improved if dexamethasone is administered to barrows within 24 h of birth. This improvement results in accelerated pig growth with no effects on carcass composition or meat quality.

Literature Cited

Burrin, D. G., R. J. Shulman, P. J. Reeds, T. A. Davis, and K. R. Gravitt. 1992. Porcine colostrum and milk stimulate visceral organ and skeletal muscle protein synthesis in neonatal pigs. J. Nutr. 122:1205–1213.

Burrin, D. G., T. J. Wester, T. A. Davis, M. L. Fiorotto, and X. Chang. 1999. Dexamethasone inhibits small intestinal growth via increased protein catabolism in neonatal pigs. Am. J. Physiol. 276:E269–E277.

Carroll, J. A. 2001. Dexamethasone treatment at birth enhances neonatal growth in swine. Domest. Anim. Endocrinol. 21:97–109.

Carroll, J. A., J. A. Daniel, D. H. Keisler, and R. L. Matteri. 2000. Postnatal function of the somatotrophic axis in pigs born naturally or by Caesarian section. Domest. Anim. Endocrinol. 19:39–52.

Cromwell, G. L., T. R. Cline, J. D. Crenshaw, T. D. Crenshaw, R. C. Ewan, C. R. Hamilton, A. J. Lewis, D. C. Mahan, E. R. Miller, J. E. Pettigrew, L. F. Tribble, and T. L. Veum. 1993. The dietary protein and(or) lysine requirements of barrows and gilts. J. Anim. Sci. 71:1510–1519.

Dvorak, M. 1972. Adrenocortical function in foetal, neonatal and young pigs. J. Endocrinol. 54:473–481.

Gallagher, N. L., E. J. Hardy, L. R. Giles, and P. C. Wynn. 1999. Neonatal treatment of piglets with growth hormone releasing hormone enhances growth by up-regulating growth hormone secretion in male pigs only. In: P. D. Cranwell, (ed.) Manipulating Pig Production. vol. 7. p 122. S.R. Frankland, Melbourne.

Gallagher, N. L., L. R. Giles, and P. C. Wynn. 2002. The development of a circadian pattern of salivary cortisol secretion in the neonatal piglet. Biol. Neonate 81:113–118.

Graham, P. L., D. C. Mahan, and R. G. Shields, Jr. 1981. Effect of starter diet and length of feeding regimen on performance and digestive enzyme activity of 2-week old weaned pigs. J. Anim. Sci. 53:299–307.

Le Dividich, J., D. Tivey, J. W. Blum, F. Strullu, and C. Louat. 1997. Effect of amount of ingested colostrums on the small intestine growth and lactase activity in the newborn pig. In: J.-P. Laplace, C. Fevrier, and A. Barbeau, (ed.) Digestive Physiology in Pigs. pp 131–135. INRA, Paris.

Lewis, A. J., M. J. Dauncey, T. J. Wester, and D. G. Burrin, 1998. Exogenous growth hormone (GH) modulates gene expression in neonatal pigs. FASEB J. 12:A852. (Abstr.)

Louveau, I., M. J. Dauncey, and J. Le Dividich. 2000. Regulation of development by nutrition and by the somatotrophic and thyroid axes in the neonatal pig. Livest. Prod. Sci. 66:121–131.

Mahan, D. C., and A. J. Lepine. 1991. Effect of pig weaning weight and associated nursery feeding programs on subsequent performance to 105 kilograms body weight. J. Anim. Sci. 69:1370–1378.

Marion, J., and J. Le Dividich. 1999. Utilization of sow milk energy by the piglet. In: P. D. Cranwell (ed.) Manipulating Pig Production. vol. 7. p 254. S.R. Frankland, Melbourne.

Matteri, R. L., B. A. Becker, J. A. Carroll, and F. C. Buonomo. 1997. Suppression of somatotroph function induced by growth hormone treatment in neonatal pigs. Domest. Anim. Endocrinol. 125:2631–2638.

NRC. 1998. Nutrient Requirements of Swine (10th ed.) National Academy Press. Washington DC.

Noblet, J., and M. Etienne. 1987. Body composition, metabolic rate, and utilization of milk nutrients in suckling piglets. Reprod. Nutr. Dev. 27:829–839.

Rhees, R. W., E. D. Lephart, and D. Eliason. 2001. Effects of maternal seperation during early postnatal development on male sexual behavior and female reproductive function. Behav. Brain Res. 123:1–10.

Schober, D. A., F. A. Simmen, D. L. Hadsell, and C. R. Baumrucker. 1990. Perinatal expression of type I IGF receptors in porcine small intestine. Endocrinology 126:1124–1132.

Silver, M. 1990. Prenatal maturation, timing of birth and how it may be regulated in domestic animals. Exp. Physiol. 75:285–307.

Silver, M., and A. L. Fowden. 1989. Pituitary-adrenocortical activity in the fetal pig in the last third of gestation. Q. J. Exp. Physiol. 74:197–206.

Solano, J. M., and L. Jacobson. 1999. Glucocorticoids reverse leptin effects on food intake and body fat in mice without increasing NPY mRNA. Am. J. Physiol. 277:E708–E716.

Tilbrook, A. J., A. I. Turner, and I. J. Clarke. 2000. Effects of stress on reproduction in non-rodent mammals: The role of glucocorticoids and sex differences. Rev. Reprod. 5:105–113.

Vamvakopoulos, N. V. 1995. Sexual dimorphism of stress response and immune/inflammatory reaction: The corticotropin releasing hormone perspective. Mediat. Inflamm. 4:163–174.

Weiler, H. A., Z. Wang, and S. A. Atkinson. 1997. Whole body lean mass is altered by Dexamethasone treatment through reductions in protein and energy utilization in piglets. Biol. Neonate 71:53–59.

Wester, T. J., T. A. Davis, M. L. Fiorotto, and D. G. Burrin. 1998. Exogenous growth hormone stimulates somatotropic axis function and growth in neonatal pigs. Am. J. Physiol. 274:E29–E37.

Widdowson, E. M., V. E. Colombo, and C. A. Artavanis. 1976. Changes in the organs of pigs in response to feeding for the first 24 h after birth. Biol. Neonate 28:272–281.